Communications entitled "Descriptions of Some Vertebrates of the Carboniferous Age," by O. P. Hay, of the American Museum of Natural History, and "Native Tribes of Western Australia," by R. H. Mathews, were presented.

The Society was then adjourned by the presiding officer.

DESCRIPTIONS OF SOME VERTEBRATES OF THE CARBONIFEROUS AGE.

(Plate VII.)

BY O. P. HAY,
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(*Read March 16, 1900.*)

The following descriptions are based partly on materials which belong to the United States National Museum, partly on materials collected by members of the United States Geological Survey, and partly on a small but very interesting collection which belongs to Mr. L. E. Daniels, of La Porte, Indiana. In the last-named collection are included several specimens of a fossil fish which probably belongs to Dr. Newberry's *Elonichthys peltigerus* and one specimen of Prof. Cope's *Amphibamus grandiceps*.

A few scales of fishes have also been received for examination from the Peter Redpath Museum, Montreal.

Dittodus latus (Newb.).

Diplodus latus, Newberry, J. S., *Proc. Acad. Nat. Sci. Phila.*, viii, 1856, p. 99; Newberry and Worthen, *Geol. Surv. Illinois*, ii, 1866, p. 59, Pl. iv, Figs. 1–1^{e}; Newberry, J. S., *Geol. Surv. Ohio*, i, 1873, Pt. 2, p. 336; *Geol. Surv. Ohio*, ii, 1875, Pt. 2, p. 44, Pl. lviii, Figs. 1–1^{b}; Woodward, A. S., *Cat. Foss. Fishes*, Pt. i, 1889, p. 12; Destinez, P., *Ann. Soc. Geol. Belg.*, xxiv, 1898, p. 220.

Dissodus latus, Miller, S. A., *N. Amer. Geol. and Pal.*, 1889, p. 714.

A nodule bearing Mr. Daniels' No. 17, from Mazon Creek, Illinois, had originally enclosed a tooth of this species of Elasmobranch. The tooth itself had been almost wholly dissolved out of

the matrix, so that with a little careful cleaning a mold was obtained, into which wax was pressed and thereby a satisfactory restoration of the tooth obtained. The tooth resembles most closely the figures of the species published in the second volume of the *Geological Survey of Illinois*, Plate iv, Figs. 1–1ᵉ. The height of the longest cusp from the lower surface of the base of the tooth is 20 mm. The edges of the compressed cusps had evidently been serrated. The base is prolonged backward, furnished with a button posteriorly and above, flat on the lower or attached side, and with a downwardly projecting tubercle near its front border.

This species was originally reported by Dr. Newberry from the coal-measures of Linton, Ohio. In 1866 it was announced from the coal-measures of Posey county, Indiana. Mr. A. S. Woodward states that it has been found in Illinois, but he probably so inferred from its being described in the Illinois Geological Survey reports. So far as I am aware, it has not hitherto been known from that State. It furnishes another proof of the close relationships of the faunæ of the Linton and the Mazon creek beds. Destinez, as above cited, has reported the species from Belgium.

Dittodus lucasi, sp. nov.

This species appears to be quite distinct from any described up to this time. The possessor of this tooth has been a fish of considerable size. The height of the longer of the two principal cusps is 18 mm., that of the shorter 15 mm., the measurements being made from the lower surface of the base. The tips are separated by a space of 16 mm. The cusps are compressed and furnished with carinæ on the edges. The latter have not, so far as I can determine, been serrated. The form of the cusps does not differ essentially from those of *D. compressus* (Newb.). Between the main cusps, standing at the very front border of the tooth and projecting farther forward than the main cusp, is a very distinct median cusp. Its height, measured from the lower surface, has been about 7 mm., possibly more. The characteristic feature of the tooth is found in its small base. This, when compared with such a species as *D. latus*, is weak. The width of the base (parallel with the jaw) is 10 mm.; the length (transverse to the jaw) is only 7 mm. On each side of

Fig. 1. Dittodus lucasi.

the midline of the base, on its posterior edge and directed backward, is a tubercle about 2 mm. long. There is no indication of any button. The plane of the main cusps makes an obtuse angle posteriorly with the plane of the lower surface of the base—that is, the main cusps project forward very distinctly. This species bears some resemblance to *D. compressus* (Newb.), but a close comparison with the descriptions and figures of that species makes it evident that it is not the same. Newberry's species had all the denticles, even the median one, distinctly crenulated. The base of *D. lucasi* is evidently of a different pattern. Newberry regarded *D. compressus* as being closely related to *D. latus*, but concluded that it possessed a smaller base, the dimensions being three lines long by two and one-half wide. O. St. John describes and figures the species (*Final Report U. S. Geol. Survey Nebraska*, 1872, p. 240, Pl. iv, Figs. 19[a], 19[b]). The base is shown to be narrower than long and to have an obtuse tubercle projecting downward anteriorly. The base of *D. lucasi* is broader than long and possesses no such tubercle.

The iron-stone nodule which furnishes the mold of this tooth bears the United States National Museum's catalogue No. 4338 and also Prof. Cope's symbol, F, 3, it having evidently been in his hands as a part of the Lacoe collection which he described. However, it was not named by Prof. Cope. It is from the coal-measures of Mazon creek, Illinois.

This species is named in honor of Mr. Frederick A. Lucas, Curator of the Department of Comparative Anatomy, United States National Museum.

CLADODUS GIRTYI, sp. nov.

This species, which appears to be distinct from any hitherto described, was collected in the coal-measure deposits of Colorado by Dr. George H. Girty, of the United States Geological Survey, and it is named in his honor. It is represented by a single tooth.

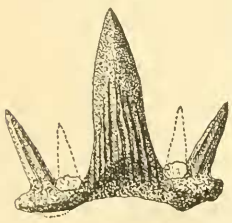

FIG. 2. Cladodus girtyi.

This consists of the base, a large median cusp and two smaller cusps on each side of the median one. Of the lateral cusps, the one on each side next to the main cusp is missing, but the size of these may be inferred from the size of the stumps remaining. They could hardly have been much smaller than the outside cusps. The base has a

width (measured parallel with the jaw) of 15 mm., and a length (measured across the jaw) of 5 mm. The outline of this base is somewhat excavated in front beneath the central cusp, forming a sinus, and projects somewhat both forward and downward just below each first lateral cusp. The central cusp has a height of 12.5 mm., measured from the under side of the base; while the outer cusps, measured in the same way, have a height of 7 mm. The main cusp has, at the base, a width of 4.5 mm. and is of a lanceolate form. It has a sigmoid flexure, the profile being, just above the base, convex in front; just below the tip, concave in front. The outer lateral cusps are straight and rather stout in form. The section of the main cusp is lenticular, or nearly semicircular, the anterior outline being much less convex than the posterior. The edges are trenchant. The anterior face of the main cusp is ornamented by about a dozen sharp costæ, separated by rounded grooves. Of these costæ, the median ones run up three-fourths the way to the tip of the tooth. Those nearer the edges are successively shorter. The posterior face of this cusp is similarly ornamented.

The lateral cusps have a hexagonal section, the sides of the hexagon being concave outwardly. Seen from the front, these cusps each present three sharp costæ separated by broad rounded furrows.

This species resembles in various respects certain other species. *Cladodus gracilis* N. and W., of the coal-measures of Indiana, has the median cusp marked by a few coarse, sharply-prominent striæ, but these are said to be somewhat irregular. The lateral denticles are very long, slender, nearly cylindrical and coarsely striated. *Cladodus intercostatus* St. J. and W., of the upper Burlington deposits of Iowa and Illinois, also possesses certain resemblances. However, the postero-superior surface of the base of that species is said to be "surmounted near the posterior margin by a laterally elongated, narrow, roughened prominence, equal to about half the lateral diameter of the base"; of this I find no indications in *C. girtyi*. The ornamentation of the cusps of the two species is also evidently much different.

It might be supposed that the species here described is more likely to be identical with *C. mortifer* N. and W., a species of the coal-measures of Illinois, Indiana, Iowa, Nebraska and Kansas. But aside from other differences, *C. mortifer* is described and fig-

ured as having a pair of conspicuous pads or bosses on the posterior part of the upper surface of the base. *C. girtyi* shows nothing whatever of this character. The only structure of this kind is the pair of protuberances found on the front of the lower surface of the base. The lateral cusps of *C. mortifer* are also said to possess sharp cutting edges and strong, sharp striæ. Good figures of *C. mortifer* may be found in St. John's paper in Hayden's *Final Report of the Geology of Nebraska*, Pl. iii, Fig. 6, and Pl. vi, Fig. 13; and in the posthumous paper by Dr. Newberry, *Trans. N. Y. Academy of Sciences*, vol. xvi, Pl. xxii, Figs. $2-2^a$.

Cladodus occidentalis Leidy also is marked by a pair of bosses on the hinder part of the upper surface of the base. The distinctness of *C. mortifer* from *C. occidentalis* is questionable.

Sagenodus.

In making a study of the scales of this genus I have had, thanks to the generosity of the authorities in charge of the vertebrate collections of the United States National Museum, access to the type specimens of the species described by Prof. E. D. Cope in a posthumous paper published in volume xxxvi of the Proceedings of the American Philosophical Society, in the year 1897. Besides these scales, there are a few others belonging to the National Museum, which were presented, as were Prof. Cope's types, by Mr. Lacoe; but which Prof. Cope seems not to have examined. I have also had the privilege of examining still other specimens of the genus, which had been obtained from Mazon creek, Illinois, by Mr. L. E. Daniels, and which yet belong to his private collection. All these have been carefully studied and compared. The result is that I recognize as valid seven out of the ten species described by Prof. Cope. This writer relied much on the forms of the scales in his identifications of the species; but a close examination of a series of scales will quickly shake one's confidence in the validity of this character. I have examined also the scales on a specimen of the existing *Ceratodus*, with which *Sagenodus* was certainly closely allied, and I find that there is a considerable variation in the forms of the scales on different parts of the body. In the region near the shoulder-girdle they are usually broad and with truncated posterior border; toward the tail the scales are more elongated and pointed. Besides these, the head is covered with a few very large scales which differ in form

from those on the body. I am convinced that we must rely more on the arrangement of the system of nutrient canals found in these scales, and on the sculpture of the surface. The availability of both these characters depends somewhat on the perfection of preservation of the scale, but usually they can be satisfactorily determined.

To the writer it seems highly probable that the fishes of this genus, like their existing relatives, lived in fresh waters, probably in rivers which emptied into the sea in which the Mazon creek deposits were formed.

In such cases, when the fishes died, their bones would be left in the bottom of the rivers where they had lived, while numbers of their scales would be likely to be carried to the sea. This may account for the fact that no portions of the bony skeletons of any of the species has yet been found in the regions of Mazon creek.

If it appears remarkable that even seven species of the genus should be found entombed in one locality, we may suppose that possibly these inhabited as many branches of some great river and therefore were, when living, denizens of widely separated regions.

It may further be said that it is not wholly certain that the species described here as members of *Sagenodus* really belong to that genus. So far as regards ornamentation, none of the scales here called *Sagenodus* much resemble the figure of the scale of the type of the genus (*S. elegans*) given by Hancock and Atthey.[1] However, Fritsch[2] has presented much better figures of the same species, and these appear to possess the generic characters of our specimens.

SAGENODUS OCCIDENTALIS (Newb. & Worth.).

Rhizodus occidentalis, Newberry and Worthen, *Geol. Surv. Illinois*, ii, 1866, p. 19, Fig. 2; *Geol. Surv. Illinois*, iv, 1870, Pl. iv, Fig. 1; Newberry, J. S., *Pal. Fishes N. Amer.*, 1890, p. 192; Miller, S. A., *N. Amer. Geol. and Pal.*, 1889, p. 611, Fig. 1173; Woodward, A. S., *Cat. Foss. Fishes*, Pt. ii, 1891, p. 348 (referred with doubt to *Strepsodus*).

Sagenodus occidentalis, Cope, E. D., PROC. AMER. PHILOS. SOC., xxxvi, 1897, p. 75, in part; Williston, S. W., *Kansas Univ. Quart.*, viii., 1899, p. 177.

[1] *Ann. Mag. Nat. Hist.* (4) vii, 1871, Pl. xiii, Fig. 3.

[2] *Fauna der Gaskohle*, ii, 1888, Pl. lxxx.

Megalichthys occidentalis, Hay, O. P., *Amer. Naturalist*, xxxiii, 1899, p. 787.

Sagenodus browniæ, Cope, E. D., Proc. Amer. Philos. Soc., xxxvi, 1897, p. 81, Pl. i, Fig. 7; Williston, S. W., *Kansas Univ. Quart.*, viii, 1899, p. 177.

This species was briefly described by Newberry and Worthen in 1866, as above cited, and was illustrated by a wood-cut. This presented the general characteristics of the scale, but did not show well the system of nutrient canals. The same author's figure of the species published in 1870 also failed to show adequately the canals. In Prof. Cope's posthumous paper of 1897 the species was first referred to *Sagenodus*.

In his synopsis of the species of the genus, on page 76, he says of *S. occidentalis*, "Concentric lines conspicuous; tessellations and radii not conspicuous." By "tessellations" was meant the areas formed by the network of canals, and by "radii" the excessively fine lines which radiate from the central part of the scale toward the free border. However, the conspicuousness both of the canals and of the radiating lines depends much on the character of the fossilization, one or the other being often effaced. This must be taken into account in considering the species. I have before me a specimen (Daniels' No. 13) which has a great resemblance to Newberry and Worthen's original figure. It is, however, proportionately longer, its width being nearly equal to its length, while the figure referred to is somewhat wider than long. The scale is also smaller than that figured by Newberry and Worthen, the length being 33 mm. There is a border of conspicuous concentric lines, and the free border is minutely striated. But there is also a very conspicuous system of nutrient canals. This system consists of one set which start from the centre of growth of the scale and radiate, some toward the attached border of the scale, others toward the free border. An upper area of the scale is occupied by similar canals, which, starting at the upper extremity of the attached border, pass somewhat toward the centre; then, turning again backward and upward, come out on the upper side of the free border. A lower area of the scale is similarly marked. A second set of canals runs approximately at right angles to the set just described and unites them, thus dividing the scale into little areas which are more or less regular parallelograms. In another specimen (Daniels' No. 12) the centre of growth of the scale is

occupied by patch of some size in which the meshwork of the canals is very irregular. In Newberry and Worthen's figure a large portion of the scale is occupied by such an irregular meshwork. This may have been due to imperfections of the scale or to errors of observation. At least, I cannot doubt that the scale before me belongs to the same species as that described by the authors named. The figures presented by the same authors in volume iv of the *Geological Survey of Illinois*, Pl. iv, Fig. 1, show a scale differing from the other considerably in form and ornamentation, yet doubtless belonging to the same species. Here the centrally placed irregular meshwork occupies much less space. The radiating canals are shown, but are not conspicuous; and the fine striæ are not shown at all. In fact, the latter are so fine that they could be truly represented only in an enlarged view of the surface. A very similar scale (Cope's F, 99) has been identified by Prof. Cope (*op. cit.*, p. 77) as *S. occidentalis*, as well as others less perfectly preserved (Cope's F, 19, 20; not F, 1, 2). In these the nutrient canals are present, but represented by very fine lines and thus not conspicuous. The fine striæ, when looked for under a lens, occupy a large portion of the surface of the scale.

If I am correct in my identification of the scale spoken of above as bearing Daniels' No. 13, then I must regard as a synonym of *Sagenodus occidentalis* the scale described and figured by Prof. Cope under the name *Sagenodus browniæ*, as cited above in the synonomy. I find nothing to distinguish it from Daniels' No. 13, except size, and this cannot be considered. The form of the scale is very much like the original figure published by Newberry and Worthen. Prof. Cope mentions *S. occidentalis* in connection with his *S. browniæ*, but states that the areolation of the latter is coarser than in any other species. Prof. Cope's figure of *S. browniæ* is faulty in that it represents the scale too broad.

SAGENODUS QUADRATUS (Newb.).

Rhizodus quadratus, Newberry, J. S., *Geolog. Surv. Ohio*, i, Pt. 2, 1873, p. 343, Pl. xxxix, Fig. 8; *Pal. Fishes N. Amer.*, 1890, p. 192; Lesley, J. P., *Dict. Foss. Penn.*, i, 1899, p. 877; Woodward, A. S., *Cat. Foss. Fishes*, Pt. ii, 1891, p. 262 (*Sagenodus* suggested).

Sagenodus quadratus, Cope, E. D., PROC. AMER. PHILOS. SOC., xxxvi, 1897, pp. 76, 77.

Dr. Newberry, as above cited, described very briefly and figured

somewhat imperfectly this species under the name *Rhizodus quadratus*. Excepting that Mr. Woodward has suggested that the species belongs to *Sagenodus*, no additional information of importance has been published since 1873. Prof. Cope, indeed, mentions the fact that he had in his hands a single scale belonging to the portion of the Lacoe collection described by him and collected at Mazon creek, Illinois, and which he thought might belong to *S. quadratus*.

Dr. Newberry's figure represents well the form of the scale and the system of concentric lines. The system of nutrient canals is, however, very inadequately shown; perhaps they were not well displayed in the specimen figured. In my hands are two scales from Mazon creek (U. S. Nat. Mus. Cat., No. 5429 from Lacoe collection, and Daniels' No. 9) which I have no hesitation in referring to Newberry's *S. quadratus*. These scales have the size and the subquadrate form which characterized the original and also the conspicuous concentric lines of growth. One of these (U. S. Nat. Mus. Cat., No. 4429), looked at casually, shows little more of the system of canals than appear in Newberry's figure. The other specimen displays them with great conspicuousness. This scale differs in size from that of Newberry's figure by only a trifling amount; one of its posterior angles is more rounded off; the attached border is also much rounded; while the free border is slightly concave.

The surface of the scale, for purposes of describing it, may be divided into four fields, viz.: (*a*) an anterior, which includes all anterior to a line drawn across the scale somewhat in front of the centre of growth and therefore occupying the anterior third of the scale; (*b*) a posterior, which is included between lines drawn from the centre of growth to each of the two posterior angles of the scale; (*c*) and (*d*), upper and lower fields which occupy the remainder of the surface. The field (*a*) is occupied by a meshwork of nutrient canals, the cells of which are more or less square, very small near the anterior border, but growing coarser and more irregular near its posterior limit. The triangular field (*b*) is occupied by canals which radiate from the centre of growth to the free border of the scale. These lie close together and are connected at intervals by cross canals. The resulting cells are usually narrow and two to four times as long as wide. The intervals between the radiating canals are filled with very fine striæ which

radiate from the centre of growth, and the observance of which require the use of a lens. The fields (*c*) and (*d*) are occupied by a very few nutrient canals which form a few large cells. The most conspicuous of these canals run from the centre of growth to the upper and lower borders. It is in these two fields that the system of concentric lines is most strongly developed. Another scale (U. S. Nat. Mus., No. 4429) does not display nearly so well the system of nutrient canals, but the remainder of the ornamentation is well shown. A third quadrate scale from the Lacoe collection (U. S. Nat. Mus. Cat., No. 4426) is the largest I have seen, having a length of 94 mm. and a breadth of 62 mm. It has the characters of the species well displayed.

In the portion of the Daniels' collection in my hands for description is another scale (Daniels' No. 8) which is of oval form, 45 mm. long by about 29 mm. wide. The ornamentation, including the network of canals of this scale, is identical with that of the scale I have above described as *S. quadratus*. No character except form will separate the two. Another scale (Daniels' No. 19) has a length of 68 mm., a width of 48 mm., and an oval form. I cannot hesitate to place both of these in *S. quadratus*.

In Prof. Cope's paper already cited, on p. 77, he refers certain scales belonging to the Lacoe collection to *S. occidentalis*, and among them one whose two impressions are labeled F. 1, F. 2.[1] This scale is 40 mm. wide and 50 mm. long. I find few characters which would permit it to be referred to *S. occidentalis*, while most of the characters of *S. quadratus* are present. I have hesitated to place it here because the area, including the centre of growth, which in most specimens is occupied by a rather coarse areolation, is in this scale broken up into an extremely fine meshwork; but the other scales differ among themselves in this respect. In form, the scale is closer to the typical *S. quadratus* than are the other oval forms that I have referred to this species, being proportionally broader and having the anterior and posterior borders more broadly rounded. It is also, as regards form, as far removed from the original specimens of *S. occidentalis* as it is from those of *S. quadratus*.

The scale mentioned by Prof. Cope as probably belonging to *S.*

[1] In the paper referred to, these scales are designated by the symbols "Figs. 1–2, 19–20, 99." This is probably an editorial error for F, 1, 2; 19, 20; 99, which symbols we find on the specimens.

quadratus, but as having an entirely exceptional form, is undoubtedly rightly identified. Its sculpture is in all respects like that of the specimen that I have above somewhat minutely described, except that the centre of growth is filled up with a very fine meshwork of canals. In this respect it resembles the broadly oval scale above mentioned. The scale now being considered has a depth of 38 mm. and a length of only 24 mm. It bears the U. S. National Museum's Cat. No. 4388.

SAGENODUS RETICULATUS (Newb. and Worth.).

Rhizodus reticulatus Newberry and Worthen, *Geol. Sur. Ill.*, 1870, iv, p. 349, Pl. iii, Fig. 9 (not Figs. 13, 14); Woodward, A. S., *Cat. Foss. Fishes*, Pt. ii, 1891, p. 262 (referred with doubt to *Sagenodus*).

Sagenodus reticulatus Cope, PROC. AMER. PHILOS. SOC., xxxvi, 1897, p. 78, Pl. i, Figs. 2, 3; Williston, S. W., *Kansas Univ. Quart.*, viii, 1899, p. 177.

Sagenodus magister Cope, PROC. AMER. PHILOS. SOC., xxxvi, 1897, p. 81, Pl. i, Fig. 8; Williston, S. W., *Kansas Univ. Quart.*, viii, 1899, p. 177.

In the report of the Geological Survey of Illinois, vol. iv, as above cited, Newberry and Worthen described the species *Rhizodus reticulatus* and illustrated it by three figures (Pl. iii, Figs. 9, 13, 14). Prof. Cope, writing in 1897, as cited, concludes that two distinct species were involved in the original description and figures and, judging from the materials before me, I believe that he was correct. Prof. Cope then, as he had an undoubted right to do, restricted Newberry and Worthen's specific name to their Figure 9 and referred the other Figures 13, 14 to his own new species *S. quincunciatus*. It is unfortunate that the figure of the type is such an unsatisfactory one. Prof. Cope's figure of *S. recticulatus* shows quite well its characters. He states that the longitudinal striæ of the distal border are not interrupted by any concentric lines, but the latter are nevertheless present in the specimen that he has figured. The agreement of these scales in form with that figured by Newberry and Worthen (Fig. 9) makes it reasonably certain that they all belong to the same species.

A careful study of Prof. Cope's types of his *S. magister* and comparison of them with the scales which he has identified with *S.*

reticulatus has convinced me that they belong to the same species of fish. A comparison of Prof. Cope's figures of the two alleged species will show that they do not differ greatly in form or in sculpture. *S. reticulatus* as figured has its free extremity considerably narrowed, but another scale identified by Prof. Cope as *S. recticulatus* (U. S. Nat. Mus. No. 4389 = Cope's F, 58) has this extremity narrowed as little as it is in *S. magister*. The scales assigned to the latter name are indeed much larger, but the scales of a young fish are naturally smaller than those of an old and larger one. The system of canals in both lots of scales covers the greater part of the surface with a fine meshwork. Only a patch near the upper border and another near the lower border have the areolation coarser. The coarseness of the areolation on the upper border of Prof. Cope's Figure 2 is exaggerated, those large cells being subdivided by finer canals which are not figured.

This species must not be confounded with that recorded as *Sagenodus reticulatus* Newberry by Mr. A. S. Woodward in his *Catalogue of Fossil Fishes*, Part ii, p. 26, and which was originally described as *Ctenodus reticulatus*.[1] The reference of both *Ctenodus reticulatus* and *Rhizodus reticulatus* to *Sagenodus* makes it necessary that the later described species, *C. reticulatus*, shall receive a new name. It may be called *Sagenodus jugosus*, in allusion to the seven radiating ridges on the crown of the tooth on which the species was based.

Sagenodus foliatus Cope.

Sagenodus foliatus Cope, E. D., Proc. Amer. Philos. Soc., xxvi, 1897, p. 77, Pl. i, Fig. 1; Williston, S. W., *Kansas Univ. Quart.*, viii, 1899, p. 177.

The form and the character of the meshwork of nutrient canals are shown in Prof. Cope's figure cited above. That figure, however, presents too conspicuously the system of concentric lines. The striæ which Prof. Cope describes are not indicated in the figure, and indeed could hardly be represented on account of their fineness. These striæ may, with a good lens, be seen to occupy a considerable portion of the surface of the scale. A feature of the network of nutrient canals is that one set of these radiate from the centre to all parts of the border of the scale. They lie close together and are frequently connected by cross canals, so that rows

[1] *Geological Survey of Ohio*, ii, 1875, p. 60.

of nearly square cells run out in all directions from the centre. I have seen no specimens except those described by Prof. Cope (U. S. Nat. Mus. Cat. Nos. 4372, 4394).

SAGENODUS LACOVIANUS Cope.

Sagenodus lacovianus Cope, E. D., PROC. AMER. PHILOS. SOC., xxxvi, 1897, p. 79, Pl. i, Fig. 5; Williston, S. W., *Kansas Univ. Quart.*, viii, 1899, p. 177.

Sagenodus conchiolepis Cope, E. D., PROC. AMER. PHILOS. SOC., xxxvi, 1897, p. 79, Pl. i, Fig. 4.

Sagenodus conchiopsis (*conchiolepis*), Williston, S. W., *Kansas Univ. Quart.*, 1899, viii, p. 177.

I regard as identical the two species which Prof. Cope has described and figured as above cited. In form the types differ in that *S. lacovianus* narrows somewhat toward the free margin and is more pointed, while *S. conchiolepis* is slightly wider posteriorly and is more truncated; but nothing can be based on such differences. As regards the ornamentation, I find no differences. The type of *S. conchiolepis* is said to have the tessellated area continued to the edge of the scale, but this depends to a great extent on perfection of preservation, and with a good lens may be observed in places even in the type of *S. lacovianus*. Prof. Cope was mistaken, too, I think, when he said that in the type of *S. lacovianus* there are no concentric lines except one coarse one. A number of others are present, but they require mostly the use of a lens. Prof. Cope stated that the sculpture of *S. conchiolepis*, as in *S. reticulatus*, radiates from near the proximal end. This I regard as an important character. An examination shows that in the types of both *S. lacovianus* and *S. conchiolepis* the centre of growth is at the extreme anterior end of the scale. In one of the specimens (U. S. Nat. Mus. Cat. No. 4391 = Cope's F, 59, 60) which Prof. Cope has identified as *S. reticulatus* a considerable number of growth-lines may be seen sweeping around in front of the centre of growth; so that, where the sculpture is well shown, this character may be employed to distinguish the scales. In the specimen of *S. reticulatus* referred to, the centre of growth is removed from the anterior border of the scale one-fifth the whole length of the scale. In the U. S. Nat. Museum there is another scale (U. S. Nat. Mus. Cat. No. 4384), from the Lacoe collection made at Mazon creek, which is intermediate between the type of *S. conchiolepis* and that of *S.*

lacovianus, so far as sculpture and form are concerned; but the size is but little less than that of the type of *S. lacovianus*.

SAGENODUS QUINCUNCIATUS Cope.

Rhizodus reticulatus, part, Newberry and Worthen, *Geolog. Surv. Illinois*, iv, 1870, p. 349, Pl. iii, Figs. 13, 14; Woodward, A. S., *Cat. Foss. Fishes*, Pt. ii, 1891, p. 262 (referred with doubt to *Sagenodus*).

Sagenodus quincunciatus Cope, E. D., PROC. AMER. PHILOS. SOC. xxxvi, 1897, p. 80, Pl. i, Fig. 6; Williston, S. W., *Kansas Univ. Quart.*, viii, 1899, p. 177.

This species has for its type the scale bearing U. S. Nat. Mus. Cat. No. 4364 = (Cope's F, 39, 40). It must have been a very abundant species in the region of Mazon creek, since besides the five specimens recorded in Prof. Cope's paper, there are in the portion of the Daniels' collection in my hands five additional scales. Four of these resemble so closely those described by Prof. Cope that no mistake can be made in their identification. One of these (Daniels' No. 10) is considerably larger than any of those seen by Prof. Cope, having a length of 31 mm. The other specimens in my hands are Daniels' Nos. 11, 20, 21, and U. S. Nat. Mus. Cat. No. 4366, the latter being a part of the Lacoe collection.

As before stated, Prof. Cope referred to this species the specimens described and figured by Newberry and Worthen in vol. iv of the *Geological Survey of Illinois*, p. 349, Figs. 13, 14. Of the correctness of the identification of Figure 14 there can be no doubt. As to Figure 13, Prof. Cope himself was in doubt, mainly because it represented a scale much larger than any other of the species in his hands. The scale before me which bears U. S. Nat. Mus. Cat. No. 4366, broken away slightly at the proximal end, has been nearly as long as the one represented by Newberry and Worthen's Figure 13, but is narrower, the length being 63 mm., the width 38 mm. The distal border is more convex than that of the figure. It has all the characteristics of the smaller specimens of *S. quincunciatus*, and it becomes more certain that the one figured by Newberry and Worthen belongs here. In this species the nutrient canals stream backward toward the posterior border, constantly anastomosing with one another, and in the middle region of the scale forming an irregular and fine areolation. Above and below the growth-centre there are a few very large cells, and similar cells

are continued backward, growing smaller to near the posterior border. It seems to me that Newberry and Worthen's Figures 13 and 14 present the characteristics of the scales of this species in a pretty satisfactory manner; although in Figure 13 the areolation is not small enough. Prof. Cope's figure of the species represents the concentric lines of growth near the posterior border entirely too conspicuous; although in his description he says that they are rarely present.

Prof. Cope has stated that one of the nodules in his hands contained two scales in mutual relation. A careful examination shows that there are three such scales present. I have before me a scale 50 mm. long taken from a modern *Ceratodus*, which in form and the general arrangement of the nutrient canals is strikingly like the large scale of *S. quincunciatus* above described. However, I find that in the living *Ceratodus* the canals do not give off so many branches, and that consequently the enclosed area or cells are much larger than in *Sagenodus*.

Sagenodus textilis Hay.

Sagenodus gurteianus Cope, Proc. Amer. Philos. Soc., xxxvi, p. 82, Pl. i, Fig. 9 (preoccupied by Cope, 1877); Williston, S. W., *Kansas Univ. Quart.*, viii, 1899, p. 177.

Sagenodus textilis, Hay, O. P., *Amer. Naturalist*, xxxiii, 1899, p. 786.

This, on careful examination of the type specimen, I regard as a very distinct species, and it is well represented in Cope's figure cited above. Under a lens no radiating striæ are seen anywhere. A trace of lines of growth is present at one of the angles, and from these I infer that the proximal extremity of the scale is that narrowed border which in Prof. Cope's figure is directed upward and toward the eft hand. No other specimens are known.

Rhizodopsis mazonius sp. nov.

This species is based on a single scale which bears the U. S. National Museum Catalogue, No. 4337. It belongs to the Lacoe collection and was obtained at Mazon creek, Ills. It was in Prof. Cope's hands and bears his numbers F, 65, F, 66, the nodule being split as usual into two portions. Prof. Cope has labeled the specimen "*Cœlacanthus* sp. Cope," but it does not belong to this genus and probably not to the family of Cœlacanthidæ. The

sculpture of the scale resembles closely that of *Rhizodopsis robustus*, as shown by Figure 3 of Plate xvi of Mr. A. Smith Woodward's *Catalogue of Fossil Fishes*, Part ii; and I place the species in that genus provisionally. The only reason I have for doubting the correctness of this assignment is the existence of a network of anastomosing lines throughout the denser portion of the scale, or something more than the proximal one-half of the area of the scale. This network is exceedingly irregular, like the cracks in dried mud, but nevertheless reminds much of the network of nutrient canals found in the scales of *Sagenodus*. In the scale before me these apparent canals are occupied by the white mineral which is so often found in fossils from this locality. It is not improbable that the bony substance of the scale has shrunken and cracked and the cracks been filled up with a foreign substance. If it shall prove that these are really nutrient canals the scale will represent apparently an undescribed genus close to *Sagenodus*.

The scale here described is ovate in form, being somewhat pointed at the proximal end. Its length is 25 mm, its breadth 14.3 mm. The proximal half has been osseous and rather thick, its thickness now, after the compression to which it has been subjected, being about equal to that of ordinary book paper.

The centre of growth or nucleus is located very close to the central part of the scale and the sculpture is disposed with reference to this nucleus. Concentric lines of growth appear on the lower surface of the osseous substance and on the underlying matrix. From the nucleus thread-like lines radiate to the proximal border of the scale and cover a broadly wedge-shaped area. Of these lines there are about ten in a millimetre. Similar lines, starting from the free border of the scale, converge toward the nucleus, but the outer ones, upper and lower respectively, pass above and below the nucleus and assume the position of concentric lines.

Strepsodus hardingi (Dawson).

Rhizodus hardingi, Dawson, J. W., *Acadian Geology*, 1868 and 1878, p. 255, Fig. 77, a–d.

Strepsodus hardingi, Woodward, A. S., *Cat. Fossil Fishes*, ii, 1891, p. 353.

This is the only North American species which has up to this time been assigned to this genus. It was named and figured by

Dr. Dawson, as cited above, but there was practically no description presented. The figures represent two scales, a small one and a portion of a large one. They show the size and form, the existence of radiating and concentric lines, and near the centre an elongated mark of some kind.

From the Peter Redpath Museum, in Montreal, through the kind offices of Prof. Frank D. Adams, I have received two specimens of the scales of this fish, both of which were presented to the Museum by Dr. Dawson. Although evidently not the subjects of his figures, they may be accepted as authentic representatives of his species. Both are large scales, but they differ much in form. One of these, having a part of one side missing, has been almost circular, with a diameter of 38 mm.; the other is oval, with a long axis of 40 mm. and a short axis of 33 mm. The large scale figured by Dr. Dawson must also have been nearly circular, while the small one was ovate. We have here an illustration of the futility of relying much on the form and size of scales.

The scales before me appear to present their inner surfaces. The circular scale has an elongated depression, whose posterior end is placed very close to the centre of the scale. From this there diverge nearly straight rows of elevated points. What we have then seems to be merely a cast of the inner surface, the points being the fillings of the pits of that surface. Concentric lines occupy a large part of the surface, being most distinct anteriorly, very indistinct posteriorly. Some evidences of longitudinal striæ, or radii, are found along the anterior border, where the surface of the scale appears abraded. The substance of the oval scale is present. Its boss, not very distinctly shown, is in the centre of the scale. From it lines of small pits and low folds diverge in straight lines to the posterior border. At the border the folds are well shown. It seems probable that these folds and rows of pits represent the course taken by the furrows of the other side of the scale. In *S. arenosus*, next described, these furrows run forward and branch in a very irregular manner. The surface of the oval scale here described shows a fine fibrillation whose lines run in various directions, apparently without relation to the other markings. The circular scale is from the Horton beds of the Subcarboniferous at Horton, Nova Scotia; the oval scale is from Pictou, and probably from the same deposits.

STREPSODUS ARENOSUS sp. nov.

There has been placed in my hands by Dr. David White, of the United States Geological Survey, for identification, the imprint of the external surface of a scale of a species of the genus *Strepsodus*. This fossil was collected by Dr. White from a shale near the base of the Lower Carboniferous rocks, in the vicinity of Collier's Station, Blair county, Pa.

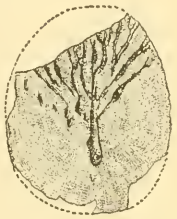

FIG. 3. Strepsodus arenosus.

The scale is somewhat imperfect, through the loss of a small portion of the distal, or free border. Nevertheless, enough is present to give us all the essential characters. The scale has had a length of about 28 mm. and a breadth of 21 mm. The proximal, or attached, end has been broadly rounded; the free end was also rounded, but probably less broadly. The most conspicuous feature of the ornamentation of the fossil is found in the system of furrows, which resemble a tree with its trunk and branches. These furrows, according to Mr. A. S. Woodward, are on the external surface of the scale. The main trunk is a furrow which began a little proximad of the centre of growth and a little less than one-third the length of the scale from its attached end. This, or a portion of it, would be represented on the other side of the scale by an elevation, or boss. At about the centre of the scale the main furrow begins to give off lateral branches in such a way that, like a deliquescent tree, it is soon lost. The smaller divisions of the branches were carried out to the free border of the scale.

The surface of the scale is everywhere covered by a fine, almost microscopic sculpture, which is produced by numerous elevated points. These are arranged in either concentric or radiating lines and often in both. There are about ten of these lines in a millimetre. On the upper and lower sides of the scale the concentric lines predominate; on the posterior portion of the scale the radiating lines are more conspicuous. These lines of minute elevations are also found in the furrows. Near the free border of the scale the elevations appear to have coalesced in rows, so as to make continuous longitudinal ridges.

The specific name has been suggested by the sculpture of the surface, which resembles grains of fine sand arranged closely together in rows.

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STREPSODUS DAWSONI sp. nov.

Rhizodus lancifer, in part, Dawson, J. W., *Acadian Geology*, 1868 and 1878, p. 210, Fig. 56[b] (not *a*).

In his *Acadian Geology*, as cited above, first in 1868, Principal, afterwards Sir William, Dawson identified, with doubt, some teeth which had been found in the deposits of the coal-measures at Pictou, Nova Scotia, with similar teeth which had been described by Dr. J. S. Newberry from the coal-measures of Ohio. Found in the same deposits at Pictou were many scales, and these too were regarded as belonging to the same species. Dr. Newberry also had found some large scales in the deposits at Linton, Ohio, which furnished the teeth, and these scales, he thought, might have belonged to the animals which had borne the teeth. It is quite evident, however, that the scales found in the two localities were not the same; and it is far from certain that the teeth are not those of Batrachia. And even if the Acadian teeth are those of fishes, there is no proof that they and the scales belong to the same species or even genus. Hence, it appears to be better to allow the teeth to stand on their own merits and to give the scales a name of their own.

From the Peter Redpath Museum I have received also a scale, No. 3076, which has every appearance of being the one which furnished the figure published by Dr. Dawson. This scale belongs to the genus *Strepsodus*, as defined by Mr. A. Smith Woodward, and I give it the name of *Strepsodus dawsoni*.

This scale has almost the exact dimensions of Dr. Dawson's figure, although the upper, or rather the hinder, end is somewhat less rounded than indicated by the figure. The length is 19 mm., the extreme width 18 mm. As seems to be indicated by the ornamentation, the inner surface is exposed to view. Nearer the anterior than the posterior end is a small elongated boss, or protuberance, a characteristic of the genus. The surface of the scale behind this is marked by numerous little pits. Dr. Dawson's figure represents these pits as existing also in front of the boss, but I find none there. They appear to be arranged somewhat in rows, which radiate from the boss to the hinder edge of the scale. All around the scale, but less distinct on the anterior end, there is a rather wide border, which is occupied by undulating and concentric lines of growth. In this border there is, on one side, an interruption in the course of these lines, as though the scale had been crumpled. Dr. Dawson's

figure represents this. At the anterior end of this scale the border just referred to is crossed by numerous fine longitudinal striæ, or radii. At the posterior end of the scale are seen wider folds. These probably have something to do with the large radiating furrows which would be found on the other side.

With the few specimens on hand it is difficult to specify characters by means of which this species may be distinguished from *S. hardingi*. Were they both found in the same formation I would hesitate to separate them, but it is unlikely that the same species occurs in the Subcarboniferous and in the Coal-measures. Were the outer surfaces of the scales exposed we might possibly discover differential characters. So far as the specimens of the two species indicate, the boss of *S. hardingi* is placed nearer the centre of the scale than is that of *S. dawsoni*. I find on the surface of the latter species no such fibrillation as is seen on *S. hardingi*, but this may be due to the character of the preservation. *S. dawsoni* is a much smaller scale than any yet reported of *S. hardingi*, but we must not place too much reliance on this fact.

Cœlacanthus robustus Newb.

Cœlacanthus robustus, Newberry, J. S., *Proc. Acad. Nat. Sci. Phila.*, viii, 1856, p. 98; *Geol. Surv. Ohio*, Pal. i, Pt. 2, 1873, p. 341, Pl. xl, Figs. 2, 2a; *Pal. Fishes N. America*, 1890, p. 228; Huxley, T. H., *Mem. Geolog. Survey United Kingdom*, x, 1866, p. 14; Woodward, A. S., *Cat. Foss. Fishes*, Pt. ii, 1891, p. 406.

Rhabdoderma robustum, Reis, O. M., *Palæontographica*, xxxv, 1888, p. 71.

A single scale of this species has the U. S. Natural Museum's Catalogue No. 4336. It also bears Prof. Cope's number F, 37, and belongs to the Lacoe collection. Prof. Cope has labeled it "*Cœlacanthus* sp. Cope, Mazon creek, Illinois." It seems to me that it certainly belongs to *C. robustus* Newb. The species was originally described from specimens found in the coal measures at Linton, O. So far as I can judge, from a comparison of the Mazon creek specimen with the description and figure presented by Newberry, there is no important difference, unless it is that of size and proportions. The Mazon creek scale has a length of 23 mm. and an extreme width of 14 mm. Dr. Newberry's specimen figured had a length of 20 mm. and a width of 14 mm., being therefore

relatively a broader scale. It is also, as represented, slightly less drawn out at the free tip than in the scale before me; but such discrepancies are scarcely to be considered. The exposed portion of the scale is embellished with fine, closely crowded, thread-like lines, which starting from the tip run forward, diverge, give off branches, and remain of the same size. A little distance in front of the tip of the scale the lateral lines cease to branch, but those along the median line of the scale continue to do so. New lines also continue to start from the border of the scale as far forward as the lines continue. This uncovered portion of the scale also possesses a very narrow border of short, very fine lines, which are directed inwards at right angles to the edge of the scale. The ornamention of the portion of the scale overlapped by the adjacent scales is quite different from that described. The centre of growth of the scale is a very little in front of the centre of area of the scale, and the thread-like lines which have just been described come forward, in the midline of the scale, nearly to the growth-centre. On the covered part of the scale numerous delicate lines of growth are arranged concentrically around the centre of growth. Besides these, there is another system of extremely fine lines which start from the anterior border of the scale and from the lateral borders as far back as the scale is covered. They are directed backward and somewhat inward so as to cross the lines of growth at an angle, large in front of the growth-centre, small above and below it.

The ornamentation of this scale is decidedly different from that of *C. elegans* as represented by Mr. A. S. Woodward.[1] According to his figure there are only about forty-five thread-lines to be counted across the widest part of the area of the scale; while in that before me there are about eighty such lines. This difference harmonizes well with Newberry's figures of the scales of the two species and with his statement,[2] when speaking of *C. ornatus*, that the ornamentation of the latter is not only relatively, but absolutely coarser than that of *C. robustus*, in individuals ten times as large.

[1] *Cat. Fossil Fishes*, Pt. ii, Pl. xiv, Fig. 2a.

[2] *Geolog. Surv. Ohio*, Pal. i, p. 340.

ELONICHTHYS PELTIGERUS? Newberry. (Plate VII.)

Elonichthys peltigerus, Newberry, J. S., *Proc. Acad. Nat. Sci. Phila.*, 1856, p. 98; Woodward, A. S., *Cat. Foss. Fishes*, Pt. ii, 1891, p. 90.

Palæoniscus peltigerus, Newberry, J. S., *Geolog. Surv. Illinois*, ii, 1866, p. 17; *Geolog. Surv. Ohio*, ii, Pt. ii, 1873, p. 345, Pl. xxxviii, Figs. 1–1[b].

The illustrations of the above species of fossil fish presented by Dr. Newberry were all derived from the same specimen, one presumably, but not certainly, from the Carboniferous shales of Linton, Ohio. Mr. A. S. Woodward, as cited above, states that the type specimen is in the collection belonging to Columbia University, of New York; but a search for it, kindly permitted by Dr. Bashford Dean, has not rewarded me with a view of it. Dr. Newberry says that he has obtained specimens of the fish from various localities in Ohio, Indiana and Illinois, those from the last State being credited to Fulton county. With several specimens in his hands, he ought to have been able to avoid any serious errors in his statement of the specific characters. Nevertheless, it is unquestionable that some errors did creep into his description and figures; and if the fishes before me belong to his species there is involved a number of errors.

In my hands are specimens of a species of *Elonichthys* which were obtained at Mazon creek, Illinois, by Mr. Daniels. These are contained in iron-stone nodules and are nearly all somewhat imperfect. The best is one which has a length of 137 mm. In this specimen the head is badly crushed, the region in front of the dorsal fin is injured, the extreme tip of the tail is gone, and there is a piece broken from the body just below the front of the dorsal fin. All the fins are shown pretty satisfactorily. This has the collector's No. 1 on it. No. 2 shows a fish which has been badly macerated and crumpled, but the ornamentation of the scales is well displayed. No. 3 is a young fish 50 mm. long and well preserved. No. 4 is a much disturbed fish showing only some scales, the pectoral and caudal fins. No. 7 consists of only the upper lobe of the caudal fin, but it shows well the striated fulcra, the caudal scales and the caudal rays.

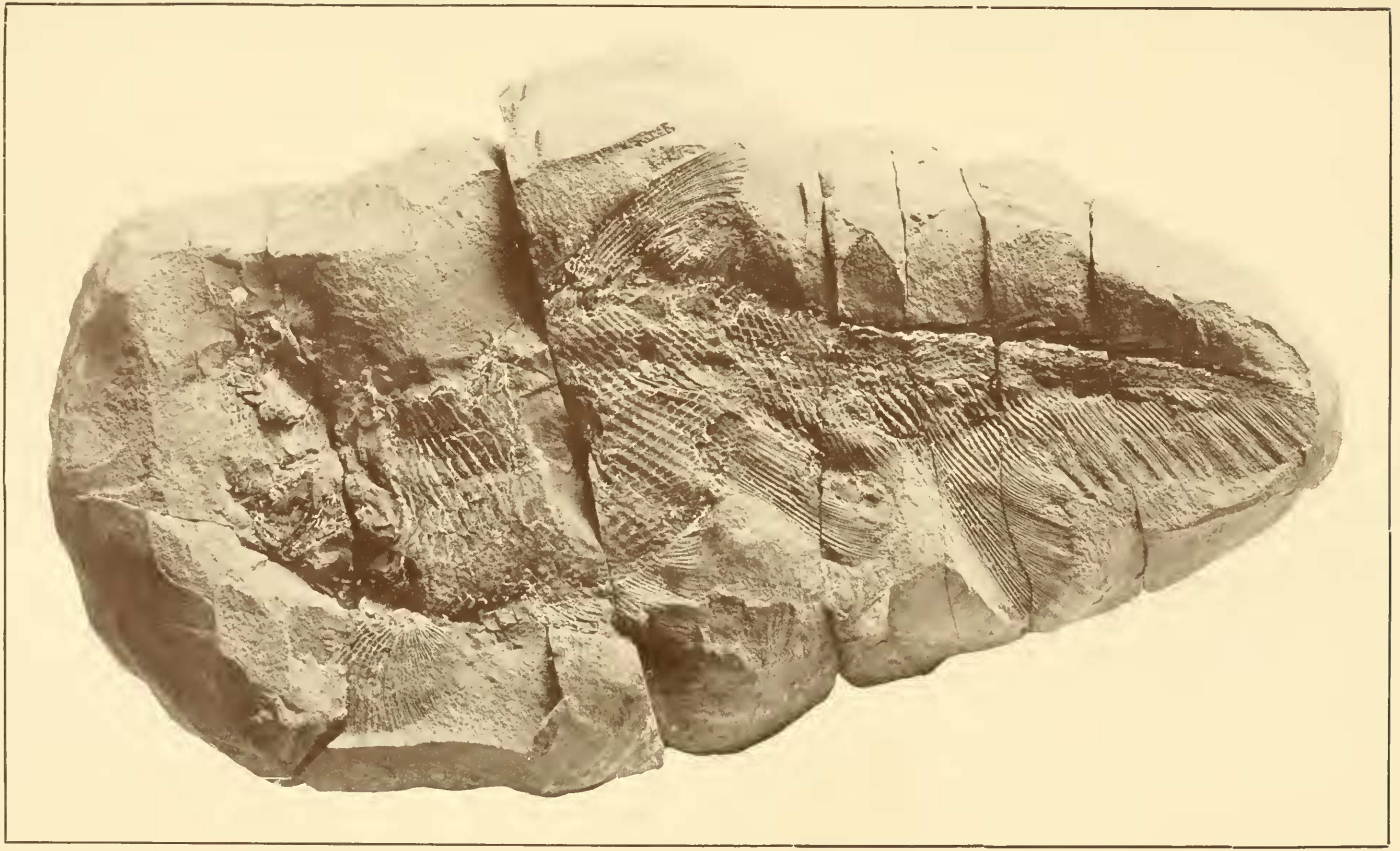
Besides this material, I have found in the collection of Columbia University another specimen evidently of the same species, from Mazon creek, Illinois, and this is labeled in Dr. Newberry's handwriting "*Palæoniscus peltigerus.*"

I have been in much doubt what disposition to make of this material. All the specimens show some important differences from the descriptions and figures of Dr. Newberry, and they may represent a distinct and undescribed species, but of this I cannot be sure. On the other hand, if it is identical with Newberry's species, the latter requires redescription, and an attempt to furnish this may result in basing a description on a species distinct from that described by Dr. Newberry.

The striking peculiarity of the type of Dr. Newberry's *E. peltigerus* and the one which suggested the specific name was the possession of a series of enlarged scales along the midline of the back, both in front of the dorsal fin and behind it. Those in front of the fin are said to be four times as large as the ordinary scales, and are so figured. Those behind the fin are said to become modified posteriorly into the strong fulcra of the tail, but Dr. Newberry's figures do not represent any fulcra present. I find such enlarged scales in only one of the specimens in my hands, that of one of the halves of nodule No. 3, which bears the impression of a little fish 50 mm. long. In all the other specimens they are missing, even when the preservation is such that they might be expected. Evidently the opportunity of seeing them depends, to a great extent, on the way in which the nodule splits.

These scales, as shown in the specimen referred to, begin close behind the head and continue backward nearly to the fin, but there is a brief interruption, probably accidental, about three-fourths of the way back. Just in front of the fin they again appear and, as shown especially in the Columbia University specimen, they change gradually into fin fulcra. This row of scales extends further forward than that described by Dr. Newberry, are in greater number and of different form; but all these differences may not be important. Immediately behind the dorsal fin I find no enlarged scales in any of the specimens. The fulcra begin as small, pointed scales and gradually enlarge.

Excepting the enlarged scales mentioned above, Dr. Newberry neither described nor figured any others peculiar in any way. Those immediately behind the shoulder girdle and on the flanks are all represented as being about as high as long. But in all of the specimens in my hands which are well enough preserved I find that the scales in several perpendicular rows just behind the shoulder girdle are twice as high as long. In case Dr. Newberry's type specimen



ELONICHTHYS PELTIGERUS HYPSILEPIS.

had such scales in this region as he has represented, it seems probable that those in my hands belong to a distinct species. These high scales gradually become reduced in height, so that those below the dorsal fin are about as high as long. The specimen 50 mm. long does not show so well the height of the anterior scales, and it is quite probable that the height increases with the size of the fish. They are shown in the Columbia University specimen. The type of Dr. Newberry's species was five inches long and ought to have revealed these high scales.

The caudal fin of the present specimens is very different from that represented in Dr. Newberry's figures, but this is probably due to the imperfection of his materials. In his figures the tail is relatively short and single-lobed, while the scaly extension of the body beyond the beginning of the fin is less than one-fourth of the length of the fish. In my material the caudal fin is fully one-third the total length of the fish, is deeply forked and has the prolongation of the body covered with pointed scales carried out apparently to its very tip. I count in the longest specimen seventy-five rays, in the Columbia University specimen about sixty, but some are probably missing in the case of both fishes. Along the upper lobe of the tail are numerous striated fulcra. These diminish in height each way from the middle of the lobe.

The dorsal fin contains about twenty-five rays. I count a few more in the large specimen, a few less in that belonging to Columbia University. The fin base equals about one-seventh of the length of the fish, the height is somewhat greater. There were about twenty-five ventral rays, possibly a few more. Dr. Newberry states that in his specimen there were only ten pectoral rays, but undoubtedly it was defective. I count easily twenty rays in the large specimen, in which the fin is well displayed. The anal fin contains about forty rays, and its length was about equal to that of the dorsal.

I do not find that the ornamentation of the scales is different from that described by Newberry. Of the scales there seem to be eight rows above the lateral line and fourteen rows below it.

The body appears to have been somewhat elevated immediately under the dorsal fin, the latter being thus lifted somewhat. The sides of this elevation are covered with two rows, an upper and a lower, of narrow, rather long scales, which are directed parallel with the fin rays. The lower jaw, as shown by specimen No. 2

of Mr. Daniels' collection, is occupied by a row of closely set sharp teeth. The branchiostegals are short and broad, the number not determinable. The mouth was large, the eyes large and placed near the end of the head.

In case it shall be proved that the specimens described above belong to a species distinct from that of Dr. Newberry, I suggest that they be called *Elonichthys hypsilepis*, with the large specimen of the Daniels collection as type, that in Columbia University as co-type.

It seems highly probable that the fish mentioned by Newberry and Worthen in volume iv of the *Geological Survey of Illinois*, p. 348, 1870, under the name *Amblypterus macropterus?* Agassiz, may in reality have belonged to the same species as those herein described. It is regarded by Mr. A. S. Woodward as being an *Elonichthys*.

Amphibamus grandiceps Cope.

Amphibamus grandiceps Cope, *Proc. Acad. Nat. Sci. Phila.*, 1865, p. 134; *Geol. Surv. Illinois*, ii, 1866, p. 135, Pl. xxxii, Fig. 8, and woodcut p. 136; Trans. Amer. Philos. Soc., (2) xiv, 1869, p. 8; Fritsch, A., *Fauna Gaskohle*, i, 1880, p. 93, Fig. 44; Miller, S. A., *N. Amer. Geol. and Pal.*, 1889, p. 618, Fig. 1178; Dana, J. D., *Man. Geol.*, 4th ed., 1896, p. 683, Fig. 1108.

In the collection belonging to Mr. Daniels there is a split nodule from Mazon creek, which contains the remains of a specimen of *Amphibamus grandiceps* Cope. The fossil has been somewhat damaged by fractures and a small portion is missing. Furthermore, as in the case of the original, the bones have been replaced by a soft white mineral, so that it has been found necessary in places to remove this and take wax impressions. Notwithstanding the lack of perfection in the fossil, it presents so many interesting features that it seems desirable that it shall be described; especially since it is, so far as I am aware, the only specimen of the species which has been found since the discovery of the original.

The entire length of this ancient salamander is 62 mm. The head is 15 mm. long and has a width almost exactly the same. The tail of the animal has been short, not exceeding probably 12 mm. Prof. Cope has represented the hinder limbs and portions of the anterior limbs. The whole hinder limb has had a length of 17 mm.; the fore limb, so far as I can determine, a length of 13 mm.

One important character exhibited in the specimen before me is the presence of ribs. The original specimen appears not to have exhibited these; and Prof. Cope concluded that they were really not present in the animal, and on this character more especially founded for it the order Xenorhachia, a group which he later abandoned. The ribs of *Amphibamus* are very slender, rather long and curved, expanded at the proximal end, and with the distinct appearance of having been double-headed. In this respect it differs markedly from *Branchiosaurus*, as described and figured by Fritsch, in which the ribs are short, stout, straight and single-headed. The number of pairs of ribs I am not able to determine with exactness. They are seen to approach to within 7 mm. of the head and to within less than this distance of what I regard as the sacral region. I make out the existence of at least twelve pairs, and there were evidently others near the head and probably still others closer to the sacrum. There are also traces of what appear to be one or two caudal ribs.

I find it impossible to determine exactly either the number or the form of the vertebræ, or the extent to which they are ossified. To *Branchiosaurus* Fritsch has attributed twenty presacral vertebræ, all of which possessed ribs except the most anterior. Prof. Cope thought that *Amphibamus* possessed probably thirteen. Basing my judgment on the apparent length of a few centra, I think that the number will fall a little short of twenty. The neural spines must have been very short. I cannot determine the presence of distinct processes for the attachment of the ribs. The vertebral column as a whole was slender, not broad as that of *Branchiosaurus*.

The head, though about as broad as long, has its greatest breadth far behind, while the outlines converge with a gentle curve to the snout, which is thus not so broadly rounded as in many of the related forms. The bones of the head were probably ornamented with a raised network of lines, enclosing pits. Prof. Cope regarded the head as being squamous. Many of the sutures between the bones are indistinct. The premaxillaries are undoubtedly separate. They appear to have each a short and broad ascending process. Exterior to this lies the exterior nares, bounded behind by the large and separate nasals, which meet along the midline. Prof. Cope indicated with doubt a suture crossing the interorbital space between its anterior and middle thirds, and another between the middle and